AF/2825
#12
1600
8-203

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Shubneesh Batra et al. §

Serial No.: 09/901,837 §

Filed: July 10, 2001 §

For: LOW TEMPERATURE REFLOW METHOD FOR FILLING HIGH ASPECT RATIO CONTACTS §

Group Art Unit: 2825 §

Examiner: Everhart, C §

Atty Docket: MCRO:199--3/FLE 95-0057.03 §

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

CERTIFICATE OF MAILING
37 C.F.R. 1.8

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Mail Stop Appeal Brief-Patents, Alexandria, VA 22313-1450, on the date below:

July 14, 2003 — Date

Michael G. Fletcher

Sir:

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 1.191 AND 1.192

This Appeal Brief is being filed in furtherance to the Notice of Appeal mailed on May 7, 2003, and received by the Patent and Trademark Office on May 12, 2003.

1. REAL PARTY IN INTEREST

The real party in interest is Micron Technology, Inc., the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 7973, frame 0902, and dated June 6, 1996.

2. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellants' legal representative in this Appeal. Micron Technology, Inc., the

Assignee of the above-referenced application, as evidenced by the documents mentioned above, will be directly affected by the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 1, 30-35, 37-44, 46-56, 58-62, 64 and 65 are currently pending, and those claims are currently under final rejection. For the reasons set forth below, however, only claims 1, 30-35, 37-44, 46, 48-56, 58-62 and 64 are the subject of this appeal. The Advisory Action dated March 24, 2003 erroneously identifies the pending claims as 1 and 30-65, but claims 36, 45, 57 and 63 were canceled by Appellant in an Amendment and Response dated October 15, 2002.

The Appellant notes that there is some confusion in the record regarding the status of dependent claims 46 and 58. Those claims are not recited by the Examiner in any list of rejected claims, but they are not acknowledged as being allowable. The Appellant notes that the scope of the limitations added by claims 46 and 58 is similar to the scope of the limitation added by dependent claim 37, which is rejected under Section 102. For purposes of this appeal, the Appellant is treating claims 46 and 58 as through they are subject to the rejection set forth by the Examiner under Section 102. The Appellant respectfully requests clarification on the status of claims 46 and 58 in the Examiner's Answer.

The Appellant further notes that dependent claims 47 and 65 are finally rejected under the judicially created doctrine of obviousness-type double patenting. Those claims are not indicated to be rejected on prior art grounds. The Appellant does not appeal the rejection of claims 47 and 65 based on obviousness-type double patenting. Instead, Appellant encloses an appropriate Terminal Disclaimer to Obviate the Examiner's rejection.

4. **STATUS OF AMENDMENTS**

In response to a Final Office Action dated January 8, 2003, the Appellant filed an Amendment Pursuant to 37 C.F.R. § 1.116 ("the Rule 116 Amendment") on March 7, 2003. In the Rule 116 Amendment, the Appellant made a minor clarifying amendment to claim 1 to conform the antecedent basis of the term "conductive material" to the term "conductive layer," which had been previously used in the claim. This amendment was made in response to a rejection of the claim under 35 U.S.C. § 112, second paragraph. An Advisory Action dated March 24, 2003 was issued in response to the Rule 116 Amendment.

In the Advisory Action, the Examiner maintained the final rejection of claims, but the Examiner gave no clear indication of whether the clarifying amendment to claim 1 would be entered (i.e. no box was checked in Section 7 of the Advisory Action). Accordingly, the Appellant is proceeding as though the clarifying amendment to claim 1 has not been entered. Rather than contest the rejection of claim 1 under Section 112 on this appeal, however, the Appellant respectfully requests the Examiner to acknowledge entry of the amendment to claim 1 in the Examiner's Answer. If the Examiner does not acknowledge the entry of the Amendment, the Appellant will amend claim 1 when the case returns to prosecution before the Examiner.

5. SUMMARY OF THE INVENTION AND OF THE DISCLOSED EMBODIMENTS

In the production of semiconductor devices, electrical contacts having high aspect ratios may be formed. When conductive material is disposed on a contact surface at temperatures lower than about 200°C, contacts formed may be subject to the undesirable occurrence of a phenomenon known as "necking" or "cusping." *See* Specification, page 2, lines 13-15. Necking (or cusping) is undesirable because it gives rise to voids at the bottom of the contact, leading to reliability and yield problems. *See* Specification, page 2, lines 15-16.

At the time of the Appellant's invention, several potential solutions to the problem of necking were being explored, but all produced undesirable results for one reason or another. *See* Specification, page 2, line 21 – page 4, line 26. For example, some potential solutions resulted in the need for higher processing temperatures, which contributed to other problems with contact formation. *See* Specification, page 2, lines 25-29.

The present claims relate to a method of forming contacts having high aspect ratios while decreasing the effects of necking or cusping. Specifically, the Appellant claimed method includes the steps of forming an impurity layer after a portion of a conductive layer has been disposed on a contact surface. Subsequently, a reflow process is applied to the conductor layer at a temperature sufficient to cause the layers to reflow. The use of the Appellant's process reduces the effects of necking or cusping by allowing the conductive material to completely fill desired cavities without voiding. *See* FIG. 2C or 3C.

6. **ISSUES**

Issue No. 1:

Whether claims 1, 30-35, 37-41, 43, 44, 46, 48-56, 58-61 and 64 are unpatentable under 35 U.S.C. § 102(e) over the Joshi reference (U.S. Patent No. 5,897,370).

Issue No. 2:

Whether claims 42 and 62 are unpatentable under 35 U.S.C. § 103(a) the combination of the Joshi reference and the Sandhu reference (U.S. Patent No. 6,040,020).

7. **GROUPING OF CLAIMS**

Independent claims 1, 30, 40 and 60, and dependent claims 31-35, 37-39, 41, 43, 44, 46, 61 and 64, will stand or fall together. Independent claim 48 and dependent claims 49-56, 58 and 59 will stand or fall together. Dependent claims 42 and 62 will stand or fall together.

8. **ARGUMENT**

Issue No. 1

As set forth above, the Examiner rejected claims 1, 30-35, 37-41, 43-44, 47-56, 59-61 and 64 under 35 U.S.C. § 102(e) as anticipated by the Joshi reference. In support of the rejection, the Examiner referred to the text of a previous Office Action dated August 22, 2002 (Paper No. 6), which states:

> Claims [sic] 1, 30-36, 37-41, 43-45, 47-57, 59-61, 63, and 64 are rejected under 35 U.S.C. 102(e) as being anticipated by Joshi, et al. (US 5,897,370)("Joshi").
>
> Joshi discloses the steps of providing a substrate comprising a contact hole in a dielectric layer which exposes a portion of the substrate(col. 6, lines 46-55 and 65-67), depositing conductive material comprising aluminum (col. 5, lines 35-48), depositing an impurity into

the conductor which lowers the melting point of the conductor and reflowing. The impurity comprises Ge, the temperature of the reflow is within the range recited in the instant claims (col. 8, lines 1-8).

Office Action of August 22, 2002, page 3.

In the Final Office Action dated January 8, 2003, the Examiner added to this rejection by stating:

> Applicant has amended to include the limitation "after a portion of the conductive material has been deposited." It is believed that Joshi et al includes this limitation, as the germanium layer can be deposited and then a further layer of conductor deposited (col. 13, lines 1-4).
>
> Final Office Action, page 2.

In the Advisory Action dated March 24, 2003, the Examiner further responded, as follows:

> Applicant has argued that in the final rejection, the Joshi reference was misinterpreted and that Joshi does not disclose the limitations added by applicant's amendment filed 10-21-02. *This argument is respectfully disagreed with because a conductor layer can comprise more than one layer*, so that the Al-Cu layer is a portion of the conductor layer, GeH4 gas is flowed, and an impurity layer is then formed and reflowed (col. 7, lines 28-34 and col. 8, lines 1-6). In another embodiment, the Al-Cu is formed, GeH4 is flowed, and the W material is formed and the layers are reflowed (col. 8, lines 40-51). The Al-Cu portion is the portion of the conductive layer which is deposited before the impurity layer is formed, and the W material is the further portion of the conductive layer which is deposited, which reads applicant's claims. The impurity layer which is formed comprises Ge and Al-Cu-Ge.
>
> Advisory Action, page 2 (emphasis added).

Appellants respectfully traverse the rejection under Section 102 based on Joshi. Anticipation under Section 102 can be found only if a single reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 227 U.S.P.Q. 773 (Fed. Cir. 1985).

For a prior art reference to anticipate under Section 102, every element of the claimed invention must be identically shown in a single reference. *In re Bond*, 910 F.2d 831, 15 U.S.P.Q.2d 1566 (Fed. Cir. 1990). To maintain a proper rejection under Section 102, a single reference must teach each and every element or step of the rejected claim. *Atlas Powder v. E.I. du Pont*, 750 F.2d 1569 (Fed. Cir. 1984).

With respect to independent claims 1, 30, 40, 48 and 60, and the claims dependent thereon, the Examiner's rejection under Section 102 based on Joshi is not proper because Joshi does not disclose every element set forth in the claims. Each of these independent claims require the introduction of impurities into the conductive layer "*after a portion of the conductive material has been deposited*" or similar wording. In other words, impurities are added during the formation of the conductive layer, after a portion of the conductive material has been deposited. Respectfully, the Appellant asserts that the Examiner has misinterpreted the teachings of Joshi *vis* the Appellant's claimed invention.

The passage of Joshi referred to by the Examiner in the final Office Action states:

> The step of flowing a gas preferably includes selecting GeH_4 Preferably, the method also includes a step of flowing a gas containing W after the step of flowing a gas containing germanium to form a hard cap.
>
> Joshi, col. 13, lines 1-4.

The Examiner relies on this passage to show that Joshi teaches the deposition of a portion of the claimed conductor layer or conductive material after the introduction of a germanium gas. This interpretation is not consistent with the teachings of Joshi as a whole.

Joshi refers to the use of W (tungsten) to form a hard cap for surface passivation or wear-resistance, *not as part of a conductor layer as exerted by the Examiner*. Specifically, Joshi states that:

> Secondly, if a hard cap is needed for surface passivation or a wear-ressistance application, the gas Geh_4 followed by WF_6 can be used to produce an in-situ hard cap of W_xGe_y.
>
> Joshi, col. 1, lines 23-26.

Joshi additionally states that:

> In another embodiment of the invention, once the material flow is achieved, a W-Ge layer 30 or the like is preferably deposited over the refractory material layer and the metallization, as shown in FIG. 4. The W-Ge layer 30 is advantageously used as a hard, wear-resistant polishing stop (e.g., it will be more resistant to an alumina slurry or the like in ferric nitrate used in chemical-mechanical polishing or the like).
>
> Joshi, col. 8, lines 15-22.

The use of Joshi's disclosure of employing a layer of tungsten alloy as a wear-resistant polishing stop is not properly equated to the Appellant's claimed operation of "forming an impurity layer in said conductor layer *after a portion of the conductor layer has been deposited*" and the additional action of "heating the conductor layer to a reflow temperature, said reflow temperature being sufficient to cause the layers to reflow." In context, Joshi clearly does not intend that the layer of tungsten alloy to be part of the conductor, whose formation is assisted by the introduction of the germanium gas. Accordingly, the rejection of claims 1, 30-35, 37-41, 43, 44, 46, 48-56, 58-61 and 64 under Section 102 based on Joshi is improper. The Appellant respectfully requests the Board to overrule the rejection of claims 1, 30-35, 37-41, 43, 44, 46, 48-56, 58-61 and 64 under Section 102 based on Joshi.

The Appellant asserts that the Examiner's rejection of independent claim 48 and dependent claims 49-56, 58 and 59 is improper for at least one additional reason. Independent claim 48 recites that a layer of impurities is deposited during the formation of a conductive layer "*after 70% of the conductive material has been deposited.*" Joshi does not even hint at the desirability of the numerical limitation recited in independent claim 48. Moreover, the Examiner has never offered any suggestion of how this limitation is met by Joshi. Accordingly, the Appellant respectfully requests the Board to overrule the Examiner's rejection of claims 48-56, 58 and 59 under Section 102 based on Joshi for this additional reason.

Issue No. 2

The Examiner rejected claims 40 and 41 under 35 U.S.C. § 103(a) as being unpatentable over the Joshi reference in view of the Sandhu reference. Specifically, the Examiner stated:

> Claims 42 and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Joshi et al in view of Sandhu et al (US 6,040,020).
>
> Joshi does not teach GeF4.
>
> Sandhu teaches the equivalence of GeH4 and GeF4 for a dopant (col. 4, lines 35-45).
>
> One of ordinary skill in the art would have been motivated to have used GeF4 in the process taught by Joshi in view of the teaching by Sandhu of the equivalence of GeF4 and GeH4 as dopants.
>
> Office Action dated August 22, 2002, page 4.

Appellants respectfully traverse this rejection. The burden of establishing a *prima facie* case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (PTO Bd. App. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the

combination. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). Accordingly, to establish a *prima facie* case, the Examiner must not only show that the combination includes *all* of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been obvious in light of the teachings of the references. *Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). When prior art references require a selected combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988).

The Appellant respectfully traverses this rejection. The rejection of claims 42 and 62 under Section 103 is based on Joshi. As set forth above, Joshi does not teach, suggest or illustrate the requirements of independent claims 40 (from which claim 42 depends) or 60 (from which claim 62 depends). This is true for at least for the reasons set forth above with respect to the rejection under Section 102. Namely, independent claims 40 and 60 recite that the introduction of impurities into the conductor region occurs "after a portion of the conductive material has been deposited." This limitation is not taught, suggested or illustrated by either Joshi or Sandhu. Thus, the combination of Joshi with Sandhu cannot render claims 42 or 62 obvious under Section 103.

For at least these reasons, the Appellant respectfully submits that claims 42 and 62 are not obvious over Joshi in view of Sandhu. Accordingly, the Applicant respectfully requests the Board to overrule the Examiner's rejection of claims 42 and 62 under Section 103.

9. **CONCLUSION**

In view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that claims 1, 30-35, 37-41, 43-44, 47-56, 59-61 and 64 are anticipated under Section 102 or that claims 42 and 62 are obvious under Section 103(a). Accordingly, Appellants respectfully request that the Board find claims 1, 30-35, 37-44, 47-56, 59-62 and 64 patentable over the prior art of record, overrule all appealed rejections and direct the allowance of the appealed claims.

In accordance with 37 C.F.R. § 1.136, Appellants request that this and any future reply requiring an extension of time be treated according to the General Authorization for Extensions of Time previously submitted.

The Appellant hereby authorizes the Commissioner to charge the fee of $320.00 for the filing of this Appeal Brief to Deposit Account No. 13-3092; Order No. MCRO:0199-3/FLE (95-0057.03).

Respectfully submitted,

Date: July 14, 2003

Michael G. Fletcher
Reg. No. 32,777
FLETCHER YODER
P.O. Box 692289
Houston, TX 77269-2289
(281) 970-4545

10. **APPENDIX OF CLAIMS ON APPEAL**

1. A method of processing a semiconductor substrate, comprising the steps of:

(a) providing a semiconductor substrate having a surface with a contact formed therein;

(b) depositing a conductor layer on the semiconductor substrate surface, wherein said conductor layer comprises a conductor;

(c) forming an impurity layer in said conductor layer after a portion of the conductor layer has been deposited, said impurity layer having a melting point temperature and surface tension less than that of said conductor; and

(d) heating the conductor layer to a reflow temperature, said reflow temperature being sufficient to cause the layers to reflow.

30. A method of forming a contact, the method comprising the following steps performed in order:

(a) providing a substrate having a contact hole formed therein, the contact hole exposing a portion of a conductive area of the substrate;

(b) depositing conductive material into the contact hole, the conductive material having a melting point;

(c) depositing an impurity into the contact hole after a portion of the conductive material has been deposited, the impurity causing the melting point of the conductive material to lower; and

(d) reflowing the conductive material and the impurity.

31. The method, as set forth in claim 30, wherein the conductive material is deposited within a temperature range of about 300 degrees Celsius to about 500 degrees Celsius.

32. The method, as set forth in claim 30, wherein said impurity is derived from an impurity source containing at least one of silicon, germanium, a halogen, a metal, and a metal-based material.

33. The method, as set forth in claim 30, wherein step (c) comprises the step of depositing impurities which migrate out of the contact hole.

34. The method, as set forth in claim 30, wherein step (c) comprises the step of depositing impurities which do not migrate out of the contact hole.

35. The method, as set forth in claim 30, wherein step (c) comprises the step of lowering the melting point of the conductive material by 10% to 60%.

37. The method, as set forth in claim 30, wherein step (c) comprises the step of depositing the impurity intermittently during step (b).

38. The method, as set forth in claim 30, wherein the impurity is deposited after 70% of the conductive material has been deposited.

39. The method, as set forth in claim 30, wherein steps (b), (c), and (d) are performed simultaneously.

40. A method of forming a contact, the method comprising the steps of:

(a) providing a substrate having a contact hole formed therein, the contact hole exposing a portion of a conductive area of the substrate;

(b) depositing conductive material into the contact hole, the conductive material having a surface tension; and

(c) depositing an impurity onto the conductive material, after a portion of the conductive material has been deposited, at a temperature that causes the conductive material to reflow, the impurity causing the surface tension of the conductive material to lower.

41. The method, as set forth in claim 40, wherein the conductive material comprises at least one of aluminum, aluminum alloy, tungsten, tungsten alloy, titanium, titanium alloy, copper, and copper alloy.

42. The method, as set forth in claim 40, wherein the impurity is derived from an impurity source comprising at least one of silane, disilane, germane, GeF_4, SiF_4, Cl_2F_2, ClF_3, ICl_3, ICl_5, $TiCl_4$, WF_6, and $TaCl_5$.

43. The method, as set forth in claim 40, wherein step (c) comprises the step of depositing impurities which migrate out of the contact hole.

44. The method, as set forth in claim 40, wherein step (c) comprises the step of depositing impurities which do not migrate out of the contact hole.

46. The method, as set forth in claim 40, wherein step (c) comprises the step of depositing the impurity intermittently during step (b).

48. A method of filling a feature having a high aspect ratio, the method comprising the steps of:

(a) depositing conductive material into the high aspect ratio feature, the conductive material having a surface tension; and

(b) depositing an impurity onto the conductive material, after 70% of the conductive material has been deposited, at a temperature that causes the conductive material to reflow, the impurity causing the surface tension of the conductive material to lower.

49. The method, as set forth in claim 48, wherein the conductive material comprises aluminum and is deposited within a temperature range of about 300 degrees Celsius to about 500 degrees Celsius.

50. The method, as set forth in claim 48, wherein said impurity is derived from an impurity source containing at least one of silicon, germanium, a halogen, a metal, and a metal-based material.

51. The method, as set forth in claim 48, wherein the conductive material comprises at least one of aluminum, aluminum alloy, tungsten, tungsten alloy, titanium, titanium alloy, copper, and copper alloy.

52. The method, as set forth in claim 48, wherein step (b) comprises the step of depositing an impurity which tends to remain in place with the conductive material deposited therewith.

53. The method, as set forth in claim 48, wherein step (b) comprises the step of depositing an impurity which tends to migrate from a place relative to the conductive material deposited therewith.

54. The method, as set forth in claim 53, wherein step (b) comprises the step of depositing an impurity which migrates out of the high aspect ratio feature.

55. The method, as set forth in claim 53, wherein step (b) comprises the step of depositing an impurity which disperses throughout the conductive material.

56. The method, as set forth in claim 48, wherein step (b) comprises the step of lowering the melting point of the conductive material by 10% to 60%.

58. The method, as set forth in claim 48, wherein step (b) comprises the step of depositing the impurity intermittently during step (a).

59. The method, as set forth in claim 48, wherein the impurity is deposited after 70% of the conductive material has been deposited.

60. A method of forming a contact, the method comprising the steps of:

(a) providing a substrate having a contact hole formed therein, the contact hole exposing a portion of a conductive area of the substrate;

(b) depositing conductive material into the contact hole, the conductive material having a surface tension; and

(c) after a portion of the conductive material has been deposited, depositing an impurity which does not migrate out of the contact hole onto the conductive material at a temperature that causes the conductive material to reflow, the impurity causing the surface tension of the conductive material to lower.

61. The method, as set forth in claim 60, wherein the conductive material comprises at least one of aluminum, aluminum alloy, tungsten, tungsten alloy, titanium, titanium alloy, copper, and copper alloy.

62. The method, as set forth in claim 60, wherein the impurity is derived from an impurity source comprising at least one of silane, disilane, germane, GeF_4, SiF_4, Cl_2F_2, ClF_3, ICl_3, ICl_5, $TiCl_4$, WF_6, and $TaCl_5$.

64. The method, as set forth in claim 60, wherein step (c) comprises the step of depositing the impurity intermittently during step (b).